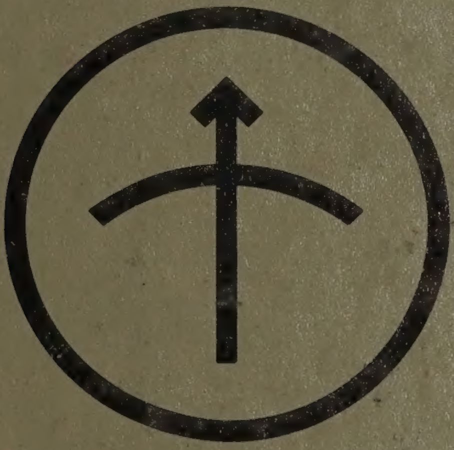
MODEL 71
SQUARE WAVE GENERATOR

Operating INSTRUCTIONS



MEASUREMENTS
A McGRAW-EDISON DIVISION
BOONTON NEW JERSEY

MODEL 71
SQUARE WAVE GENERATOR

SER. 688

Operating
INSTRUCTIONS

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MEASUREMENTS
A McGRAW-EDISON DIVISION
BOONTON NEW JERSEY

CONTENTS

CHAPTER 1. INTRODUCTION.

		Paragraph	Page
Section I.	GENERAL.		
	Scope of Manual	1	1
Section II.	DESCRIPTION AND DATA.		
	General	2	1
	Technical Characteristics	3	1
	Components Supplied	4	2
	Export Packaging	5	2

CHAPTER 2. OPERATING INSTRUCTIONS.

Section I.	SERVICE UPON RECEIPT OF EQUIPMENT.		
	Unpacking	6	3
	Preliminary Precautions	7	3
Section II.	CONTROLS AND INSTRUMENTS.		
	Frequency	8	3
	Peak Volts	9	3
	Output	10	3
	Power	11	3
	Synchronizing Input	12	3
	Square-Wave Output	13	5
	R.F. In	14	5
	R.F. Out	15	5
Section III.	OPERATION.		
	Installation and Adjustment	16	5
	Preliminary Operational Checks	17	5
	Operation and Use	18	5
	Use of Square-Wave Output	19	7
	Square-Wave Modulation of Carriers	20	7

CHAPTER 3. MAINTENANCE INSTRUCTIONS.

Section I.	MAINTENANCE.		
	General	21	9

CHAPTER 4. EQUIPMENT USED WITH MODEL 71.

Section I.	RECOMMENDED ACCESSORIES.	22	11

CONTENTS—*Continued*

CHAPTER 5. TECHNICAL SERVICE—MAINTENANCE INSTRUCTIONS.

			Paragraph	*Page*
Section	*I.*	GENERAL.		
		Scope	23	13
Section	*II.*	CONDENSED THEORY OF OPERATION.		
		General	24	13
		Multivibrator Oscillator	25	13
		Power Supply	26	13
		Buffer Clipper Stage	27	13
		Square-Wave Output Stage	28	13
		Sync Output Stage	29	14
		Modulator Stage	30	14
Section	*III.*	TROUBLE LOCATION.		
		Localizing the Trouble	31	14
Section	*IV.*	PRE-ADJUSTMENT PROCEDURE.		
		Test Equipment Required	32	14
Section	*V.*	ADJUSTMENT PROCEDURES.		
		General	33	14
		Output Variation	34	14
		Asymmetry Check	35	15
		Frequency Calibration Check	36	15
		Frequency Decade Check	37	15
		Output Voltage Check	38	15
Appendix	I.	Storage and Shipment		
Appendix	II.	Table of Replaceable Parts		
Appendix	III.	Bibliography on Square-Wave Testing		

FIGURES

Figure 1.	Front View of Model 71	iv
Figure 2.	Identification of Controls	4
Figure 3.	External Connections for Use of Square Waves	6
Figure 4.	External Connections for Use of S-W Modulator	8
Figure 5.	Block Diagram	10
Figure 6.	Rear View of Uncased Instrument	12
	Complete Schematic Diagram	Rear of manual

TABLES

Table I.	Table of Components	2
Table II.	Export Packaging Data	2
Table III.	Trouble-Shooting Chart	9
Table IV.	Tube Voltage Chart	11

Additional Information with regard to the applications and maintenance of this equipment will be available from time to time. Users of the Model 71 are urged to discuss their problems with us and to suggest such modifications as might make the instrument more adaptable to their special requirements.

Maintenance difficulties should be reported before proceeding with actual repairs, since our familiarity with such problems will usually suggest a simpler procedure.

Engineering Department
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U. S. A.

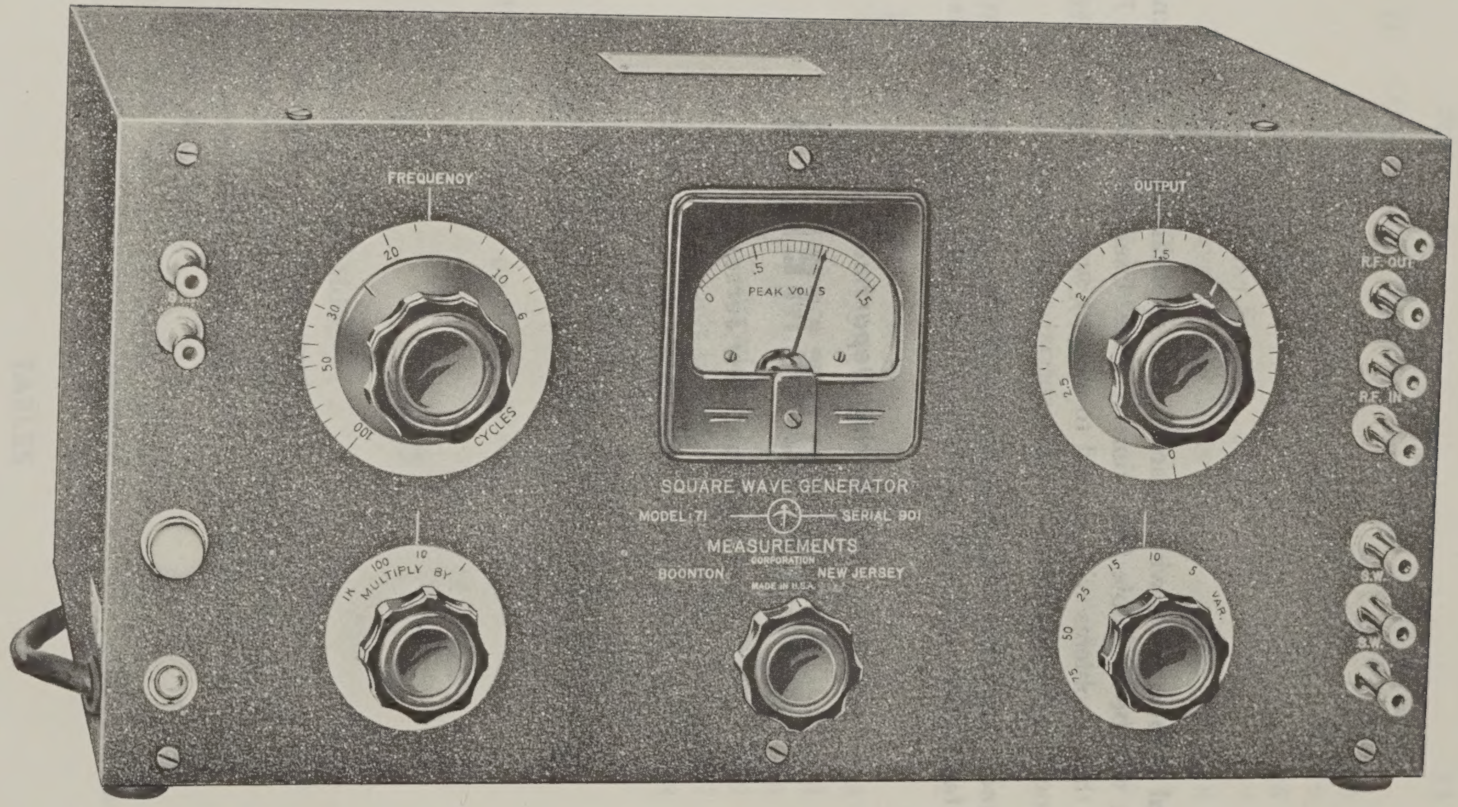

Figure 1. Front View of Model 71.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. SCOPE OF MANUAL.

a. This manual describes the basic operation, construction and maintenance of the Model 71 Square-Wave Generator. Following the text of the manual are three appendices. Appendix I describes the recommended procedure for preparing the instrument for prolonged storage or re-shipment. Appendix II contains an Identification Table of Replaceable Parts, listing the reference symbols, name and description, function and drawing number of each part required for maintenance. Appendix III is a bibliography on the subjects of square wave theory and testing.

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Section II. DESCRIPTION AND DATA

2. GENERAL.

a. The Model 71 Square-Wave Generator, see Figure 1, is a completely self-contained source of symmetrical square waves covering the fundamental range of 6 to 100,000 cycles per second. It is suitable for testing the characteristics of networks, amplifiers and many other systems over the audio and video ranges from one cycle to several megacycles per second.

b. It is recommended that the user of the Model 71 study the references listed in APPENDIX III in order to obtain a comprehensive understanding of the fundamentals of square wave testing.

NOTE:

The purchaser is invited to correspond with Measurements Corporation concerning special modifications of the Model 71 which can be made at nominal cost for operation at low frequencies or for special precision output attenuators, etc.

3. TECHNICAL CHARACTERISTICS.

a. FREQUENCY CHARACTERISTICS:

(1) Continuously variable from 6 to 100,000 cycles per second in the following four overlapping ranges:

6-100 cycles per second
60-1000 cycles per second
0.6-10 kilocycles per second
6-100 kilocycles per second

b. FREQUENCY CALIBRATION:

(1) Frequency dials are individually calibrated to ±5% on the X100 range to compensate for manufacturing differences in the variable resistors which are the frequency-determining elements. The MULTIPLY BY decades are checked to ±10%.

(2) No guarantee as to frequency accuracy is made.

(3) Synchronizing input terminals are provided so that the internal multivibrator oscillator may be synchronized with an external frequency, or to a multiple or submultiple thereof, when it is desired to have a precise output square-wave frequency.

c. WAVE SHAPE:

(1) Rise time less than 0.2 microsecond with negligible overshoot at 75 peak volts output.

(2) Rise time is less than 0.1 microsecond at outputs of less than 5 volts peak.

NOTE:

Model 71's having serial numbers under 641 may have longer rise times. These instruments may be serviced and modernized by Measurements Corporation at a nominal cost.

(3) Output wave is a symmetrical square wave with closely equal half periods superimposed on a negative d-c component equal to half the peak-to-peak magnitude of the square wave.

(4) A clean flat top, with less than 5% overshoot, is maintained over the complete frequency range. It is necessary to carefully select the 6AG7 output tube in order to obtain a clean wave shape.

Early type 6AG7 tubes often produced poor output wave shapes caused by the cathode interfacial properties of these tubes.

d. OUTPUT VOLTAGE AND IMPEDANCE:

(1) Step attenuator giving a negative-going square wave of approximately 75, 50, 25, 15, 10, 5 negative peak volts fixed and 0 to 2.5 negative peak volts continuously variable, all at 20 ohms per volt output impedance. (See Figure 3(a)).

(2) Synchronizing output voltage 25 volts negative peak across 1500 ohms.

(3) Synchronizing input impedance consists of a 100,000 ohm resistor in series with a 0.003 mfd. condenser connected to the grid circuit of one multivibrator tube.

e. MODULATOR:

(1) Built-in modulator for square-wave modulation of r-f carriers.

(2) Recommended carrier input is 0.1 to 1 volts. Maximum carrier input is 5 volts.

(3) Modulator translation gain is approximately 0.1.

(4) Output impedance is 600 ohms.

f. POWER SOURCE:

(1) 117 volts, 50-60 c.p.s.

(2) Power input 100 watts.

4. COMPONENTS SUPPLIED.

TABLE I. TABLE OF COMPONENTS

Quantity	Description	Dimensions			Unit Weight	Volume Cu. ft.
		Height	Width	Depth		
1	Model 71 Square-Wave Generator	7″	15″	7½″	20 lb.	0.46
1	Manual of Operating Instructions					
3	Tube, RTMA #6J5, installed					
1	Tube, RTMA #0D3/VR-150, installed					
1	Tube, RTMA #5Y3G, installed					
2	Tube, RTMA #6AG7, installed					
1	Tube, RTMA #6SA7, installed					

5. EXPORT PACKAGING.

a. Packed for export, the Model 71 is crated in a wooden box.

TABLE II. EXPORT PACKAGING DATA.

Number of Packages	Dimensions			Weight	Volume Cu. ft.
	Height	Width	Depth		
1	17″	22″	18″	55 lb.	3.9

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

6. UNPACKING.

a. Take care when unpacking or handling the equipment. Follow the procedure outlined below when unpacking the instrument.

(1) Place the packing case in a location where it can be opened easily.

(2) Remove nails with a nail puller and remove the top of the packing case.

(3) Lift the generator from the packing case and remove the paper wrapping.

(4) Inspect the case and controls on the front panel for possible damage during shipment.

7. PRELIMINARY PRECAUTIONS.

a. Connect the Model 71 to a power source of 117 volts, 50-60 c.p.s., with at least 100 watts capacity.

b. During operation make certain there is ample clearance between the rear of the case and the wall or other object to provide sufficient ventilation.

Section II. CONTROLS AND INSTRUMENTS

8. FREQUENCY.

a. The FREQUENCY CYCLES dial, I2, located in the upper left-hand corner of the front panel as shown in Figure 2, provides a continuous variation in frequency by rotation of the dual variable resistor, R4.

b. The MULTIPLY BY dial, I4, located in the lower left-hand corner of the panel, provides decade step changes in frequency of 1, 10, 100 and 1000 by rotation of the step switch, S2, which switches the multivibrator tuning capacitors C2 through C9.

c. The square-wave frequency is obtained by multiplying the CYCLES dial reading by the MULTIPLY BY multiplying factor.

9. PEAK VOLTS.

a. The PEAK VOLTS meter, M1, located in the upper center of the panel is calibrated so that when it is set to the 1.0 point on its scale, the peak amplitude of the output square wave is indicated by the OUTPUT attenuator dials.

b. The knob directly below the meter is used to set the PEAK VOLTS meter to the reference value 1.0 by varying the Output Adjustment resistor, R14. This knob also serves as a "balance control" for balancing out the residual square-wave component at the R.F. OUT terminals when the internal modulator is used to modulate r-f carriers with square waves.

10. OUTPUT.

a. The OUTPUT ATTENUATOR dial, I5, located in the lower right-hand corner of the panel, provides a stepped output of 0, 5, 10, 15, 25, 50 and 75 negative peak volts by switching the resistors R28 through R33. When this dial is set to VAR the variable potentiometer R27 is connected to the output terminals.

b. With the dial, I5, set to VAR, the VARIABLE OUTPUT dial, I3, located above I5, provides a continuously variable output of 0 to 2.5 negative peak volts.

11. POWER.

a. The POWER switch, S1, located in the lower left-hand corner of the panel controls application of line voltage to the primary of the power transformer, T1.

b. Directly above the POWER switch is the pilot light, I1.

c. The fuses, F1 and F2, are located in the power plug.

12. SYNCHRONIZING INPUT.

a. The SYN. terminals in the upper left-hand corner of the panel provide means for injecting a signal from an external source into the grid circuit of the built-in multivibrator in order to synchronize it with the external signal, or with a multiple or submultiple of this signal.

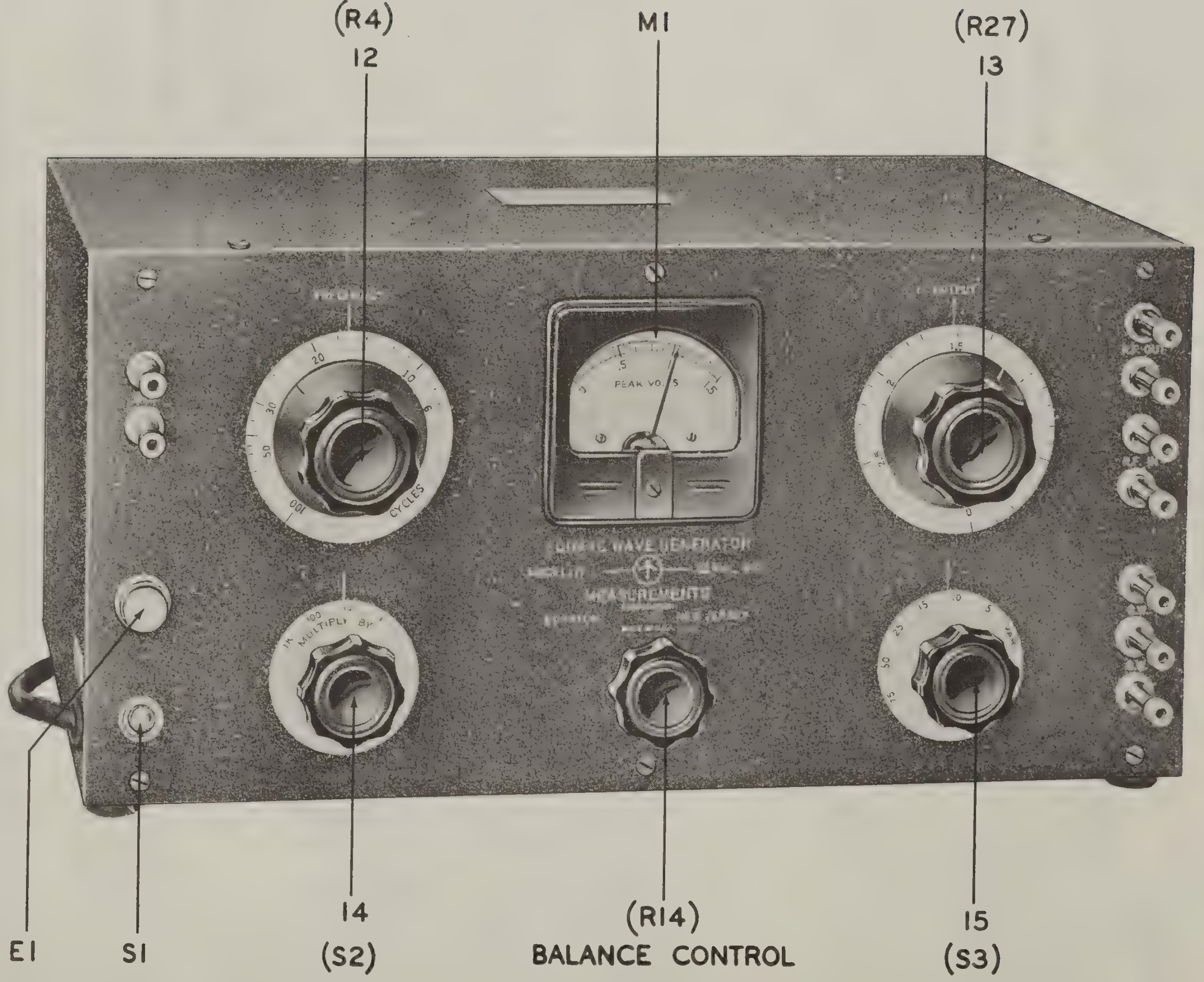


Figure 2. Identification of Controls.

13. SQUARE-WAVE OUTPUT.

a. The three terminals marked S.W. located in the lower right-hand corner of the panel are the SQUARE WAVE OUTPUT terminals.

b. The center terminal is the output ground terminal.

c. The upper terminal provides the VARIABLE SQUARE WAVE output.

d. The lower terminal provides a SYNCHRONIZING OUTPUT square-wave signal of approximately 25 volts peak for oscilloscope sweep synchronizing, or similar purposes.

14. R.F. IN.

a. The R.F. IN terminals located directly above the S.W. terminals provide means for connecting an external signal to the built-in R.F. MODULATOR so that the external signal may be modulated with a square wave.

15. R.F. OUT.

a. The R.F. OUT terminals located directly above the R.F. IN terminals are the square-wave-modulated r-f signal output terminals.

Section III. OPERATION

16. INSTALLATION AND ADJUSTMENT.

a. The Model 71 Square Wave Generator is a portable electronic test instrument which requires no permanent installation. Sufficient clearance should be provided between the rear of the case and other objects to insure ample ventilation. No preliminary adjustments are required prior to operation.

17. PRELIMINARY OPERATIONAL CHECKS.

a. Connect the line cord to a source of 117-volt, 50-60 c.p.s. power of at least 100-watts capacity and place the POWER switch, S1, in the up position. The pilot light will indicate that the power is applied. Allow one minute for the tubes to warm up.

b. Rotate the OUTPUT ADJUSTMENT knob located below the meter to its full clockwise position.

c. Select, in turn, each of the FREQUENCY ranges on the MULTIPLY BY dial, I4. For each range, rotate the FREQUENCY dial, I2, over its entire calibrated scale. The OUTPUT METER, M1, should then give an indication greater than 1.0 for any frequency selected, if the OUTPUT TERMINALS, S.W., are not connected to any external equipment.

NOTE:

Below 50 cycles the meter pointer will vibrate or oscillate about its average reading. This is a normal condition, because the meter is capable of following low-frequency oscillations.

d. Connect a cathode-ray oscilloscope to the upper two SQUARE WAVE OUTPUT terminals S.W. as shown in Figure 3(a). If it is desired to use an external synchronizing signal with the oscilloscope, connect the lower S.W. terminal of the Model 71 to the Sync terminal of the oscilloscope as shown by the dashed line in Figure 3(a).

e. If the oscilloscope employed is of the wide-band type with a good transient response characteristic, a clean square wave with sharp vertical sides and a horizontal flat top should be observed for all frequency settings of the Model 71. Some improvement in rise time may be obtained by adjusting the OUTPUT ADJUST knob located below the meter and by setting the attenuator for an output of less than 5 volts.

f. If the oscilloscope employed to check the Model 71 is of the general-purpose type with restricted low-frequency and high-frequency responses, the shape of the square waves observed may be distorted. This is, of course, due to the poor transient response of the amplifiers in the oscilloscope.

NOTE:

If the low-frequency cut-off of the CRO is at f_1 and the high-frequency cut-off is at f_2, then, in general, the CRO will display clean square waves for square-wave repetition frequencies extending approximately from $10f_1$ to $f_2/10$.

g. Any indication of faulty operation should be reported immediately to Measurements Corporation.

18. OPERATION AND USE.

a. Set-up procedure

(1) Connect the line cord to a source of 117-volt, 50-60 c.p.s. power.

(2) Place POWER switch in up position, and allow one minute for tubes to heat up.

(3) If very constant amplitude and frequency output are of importance, it is desirable to operate the Model 71 from a regulating transformer.

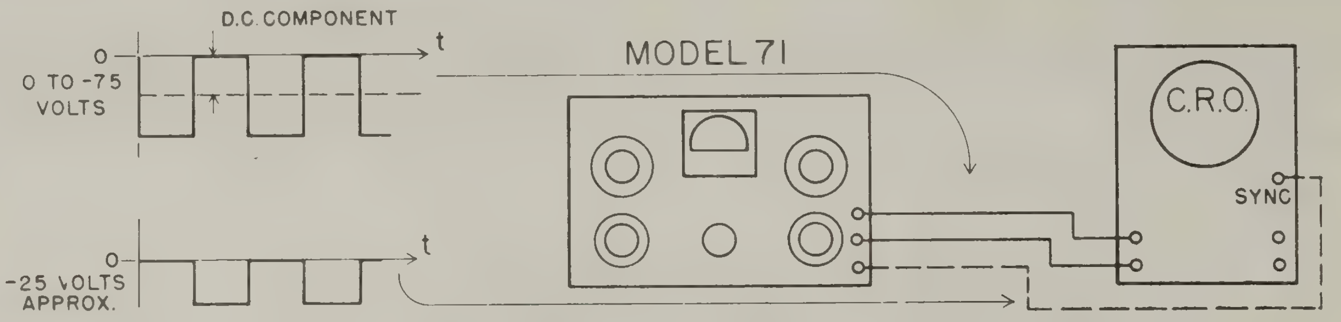


Figure 3(a)—PRELIMINARY OPERATIONAL CHECK OF WAVE FORM.

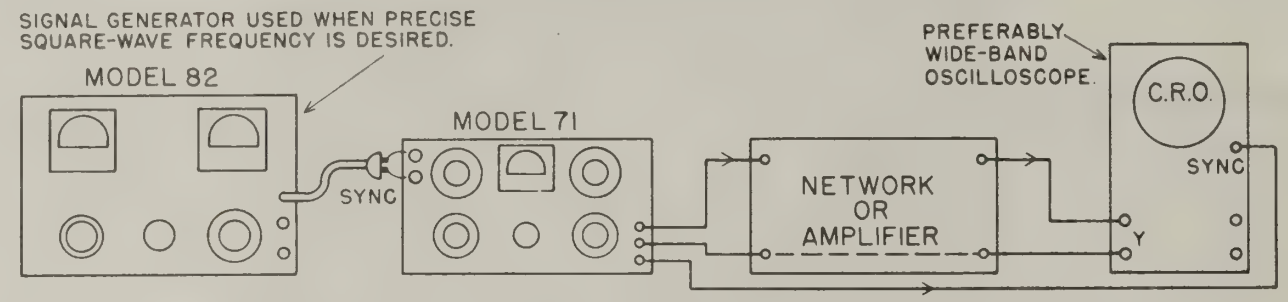


Figure 3(b)—SQUARE-WAVE TEST OF NETWORK, AMPLIFIER OR OTHER DEVICE.

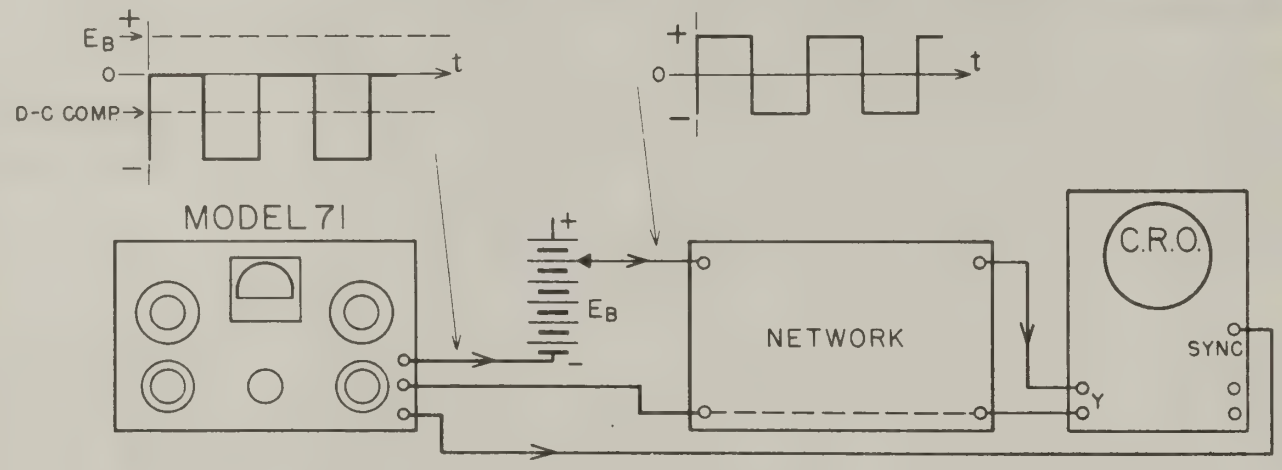
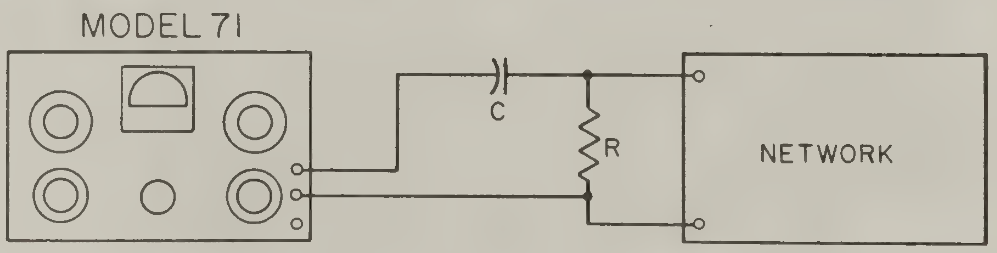


Figure 3(c)—BATTERY USED TO CANCEL D-C COMPONENT.



CRITERION OF CHOICE OF R-C VALUES SAME
AS FOR COUPLING NETWORK IN AN AMPLIFIER.

Figure 3(d)—CAPACITOR USED TO ELIMINATE D-C COMPONENT.

Figure 3. External Connections for Use of Square Waves.

19. USE OF SQUARE WAVE OUTPUT.

a. Square-Wave testing

(1) Figure 3(b) is a block diagram showing how the square-wave output of the Model 71 is used to test a network, amplifier or other three-terminal system (four terminals with a pair of terminals common to input and output).

(2) In applications where the d-c component is undesirable, it can be removed by connecting a dry battery ("C" batteries or mercury batteries are excellent for this purpose) in series with the output as shown in Figure 3(c). The d-c component can be completely balanced out for any particular setting of the output attenuator and for any particular load impedance by using adjustable taps on the battery and then varying the output adjusting knob below the meter.

NOTE:

> Care should be exercised to prevent burning out the attenuator, particularly when the attenuator is set at VAR, by having the battery properly connected, especially when the d-c resistance of the load is low.

(3) A series capacitor may also be used to remove the d-c component in the square wave, as shown in Figure 3(d). The size of the capacitor required is a function of the square-wave frequency and the magnitude and type of load impedance connected to the Model 71. Too low a blocking capacitor will produce some wave-form distortion.

b. Use of synchronizing signal

(1) If a signal generator is used for synchronizing purposes, the voltage injected into the Model 71 should be kept to as low a value as will produce clean synchronization. Too large a synchronizing input may produce unequal half periods of the square wave.

20. SQUARE-WAVE MODULATION OF CARRIERS.

a. Square-wave-modulated carriers

(1) The Model 71 contains a 6SA7 modulator stage for applying square-wave modulation to r-f carrier frequencies up to approximately 10 to 20 megacycles.

(2) The carrier input terminals are marked R.F. IN. The square-wave-modulated carrier is obtained from the terminals marked R.F. OUT. A typical set-up is shown in Figure 4.

(3) In addition to the square-wave-modulated carrier, there is present in the plate circuit of the modulator some of the square-wave modulating voltage. This undesirable component is balanced out by inserting a square-wave voltage of opposite phase, obtained from R27, in series with the plate load resistor, R21, of the 6SA7. The knob below the output meter is used as a balancing control. The square-wave-modulated carrier should be viewed on a wide-band oscilloscope, and the balancing control should be adjusted to make the axis which is visible during the carrier "off" period coincide with the "time" axis of the CRO sweep. A d-c switching transient may remain if a low-level carrier is employed.

(4) It is recommended that carrier signal input amplitudes of 0.1 to 1 volt be employed and that attenuation be provided after modulation in order to minimize the patterns caused by the d-c switching transient. A test for the presence of spurious patterns arising from this transient is to decrease the magnitude of the applied carrier to zero and to note whether there is any residual pattern. If no pattern, or only a small pattern, is present, the switching transient has been properly balanced out.

(5) It is not ordinarily necessary to synchronize the square-wave modulating signal with the carrier frequency. However, these signals may be synchronized by using the circuit arrangement in Figure 4. Stable synchronization may be achieved only if there is not too great a difference between the square-wave frequency and the carrier frequency. (For example, it would be difficult to synchronize a 10-cycle square wave with a 1-megacycle carrier.) It is desirable to place a high-resistance pad, or potentiometer, between the signal-generator output and the S.W. input of the Model 71 in order to control the magnitude of the injected signal for clean synchronization.

(6) It is sometimes difficult to synchronize the multivibrator oscillator positively without "jitter" if the synchronizing voltage is sinusoidal. If trouble is experienced in this respect, it is desirable to derive a synchronizing pulse from the sine wave by application of the clipping and differentiation process.

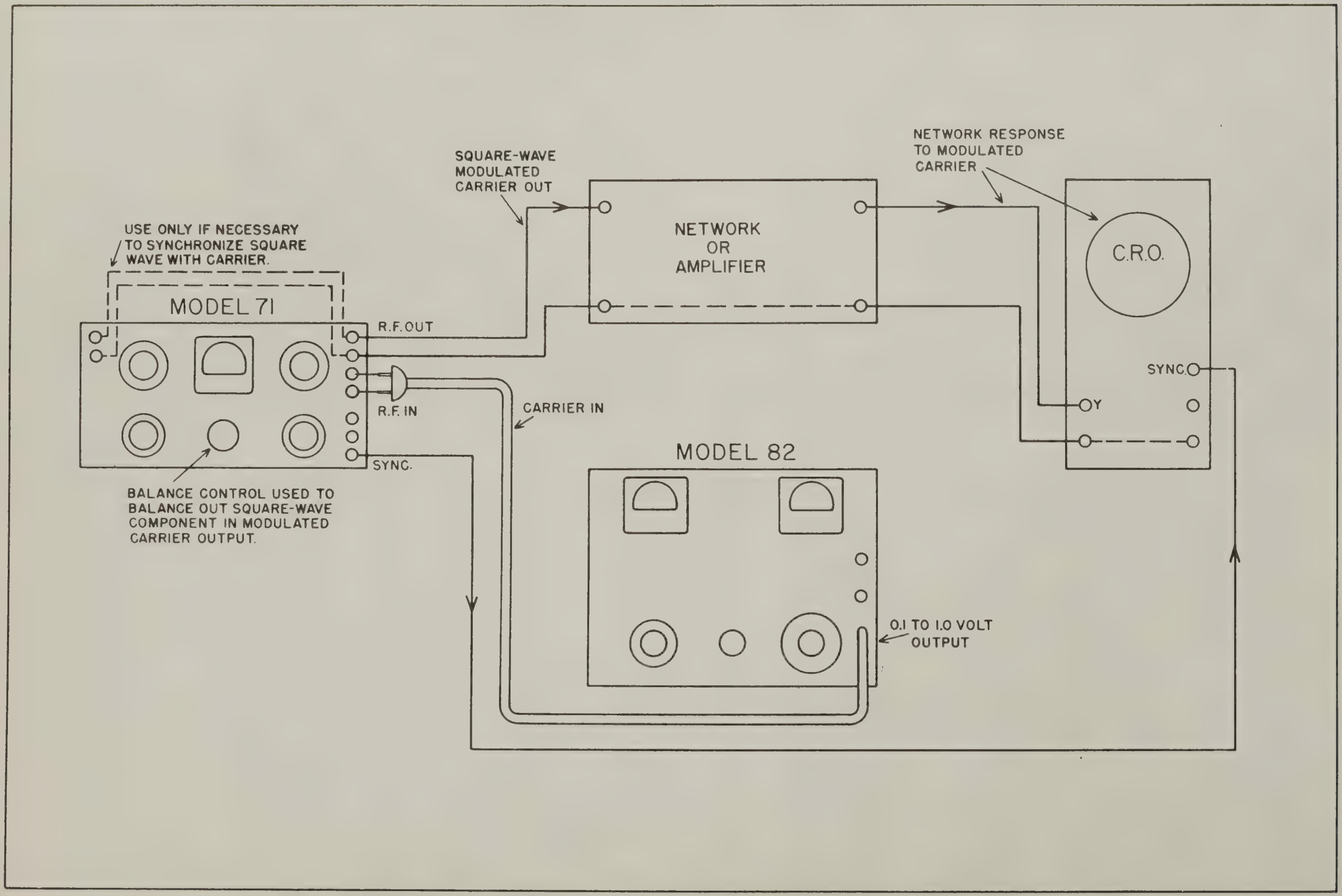

USE ONLY IF NECESSARY TO SYNCHRONIZE SQUARE WAVE WITH CARRIER.
MODEL 71
R.F. OUT
R.F. IN
SYNC.
BALANCE CONTROL USED TO BALANCE OUT SQUARE-WAVE COMPONENT IN MODULATED CARRIER OUTPUT.
SQUARE-WAVE MODULATED CARRIER OUT
NETWORK OR AMPLIFIER
NETWORK RESPONSE TO MODULATED CARRIER
C.R.O.
SYNC.
Y
CARRIER IN
MODEL 82
0.1 TO 1.0 VOLT OUTPUT

Figure 4. External Connections for Use of S-W Modulator.

CHAPTER 3

MAINTENANCE INSTRUCTIONS

Section I. MAINTENANCE

21. GENERAL.

a. Preventive maintenance procedure is not recommended for the Model 71. Preventive maintenance is a series of operations including inspection, adjustment, lubrication, etc., recommended periodically for certain types of equipment to eliminate the possibility of unexpected interruptions in service. Critical adjustments may be disturbed by too-frequent inspection by personnel unfamiliar with the design of the Model 71 causing errors in data that would be much more serious than an occasional operational failure.

b. If failure occurs, the instrument should be checked by the procedure outlined in Paragraph 17 (Preliminary Operational Checks), and if trouble, other than a defective tube, is indicated, the instrument should be returned to Measurements Corporation.

c. For analyzing troubles, see Table III and Table IV.

d. To remove the case of the Model 71, unscrew two screws located at the top and two screws located at the bottom front edges of the case. The unit may then be lifted directly from its case.

TABLE III. TROUBLE SHOOTING CHART.

Trouble	Possible Cause	Remedy
Pilot lamp does not light.	Defective power plug, receptacle or cord. Defective power switch (S1). Blown fuses (F1 or F2). Defective pilot lamp. Defective power transformer.	Check for poor connection or continuity. Replace if necessary. Replace switch. Replace fuse and/or check fuse holder. Replace lamp and/or check socket. Replace T1.
Meter shows no indication.	Tube (V5) defective. Tube (V4) defective. Tube (V6) defective.	Replace V5. Replace V4. Replace V6.
Meter reads high.	Tube (V3) defective. Tube (V6) defective.	Replace V3. Replace V6.
Meter reads low.	Tube (V1) defective. Tube (V6) defective. Tube (V2) defective.	Replace V1. Replace V6. Replace V2.
No SYNC output.	Tube (V7) defective.	Replace V7.
No output when S3 is at VAR.	Tube (V6) defective. Defective potentiometer R27. Defective switch, S3.	Replace V6. Repair or replace R27. Repair or replace S3.
No output when S3 is at fixed tap.	Tube (V6) defective. Defective Switch, S3. Defective fixed resistor R28 to R33.	Replace V6. Repair or replace S3. Replace resistor.
No modulated carrier output.	Tube (V8) defective.	Replace V8.

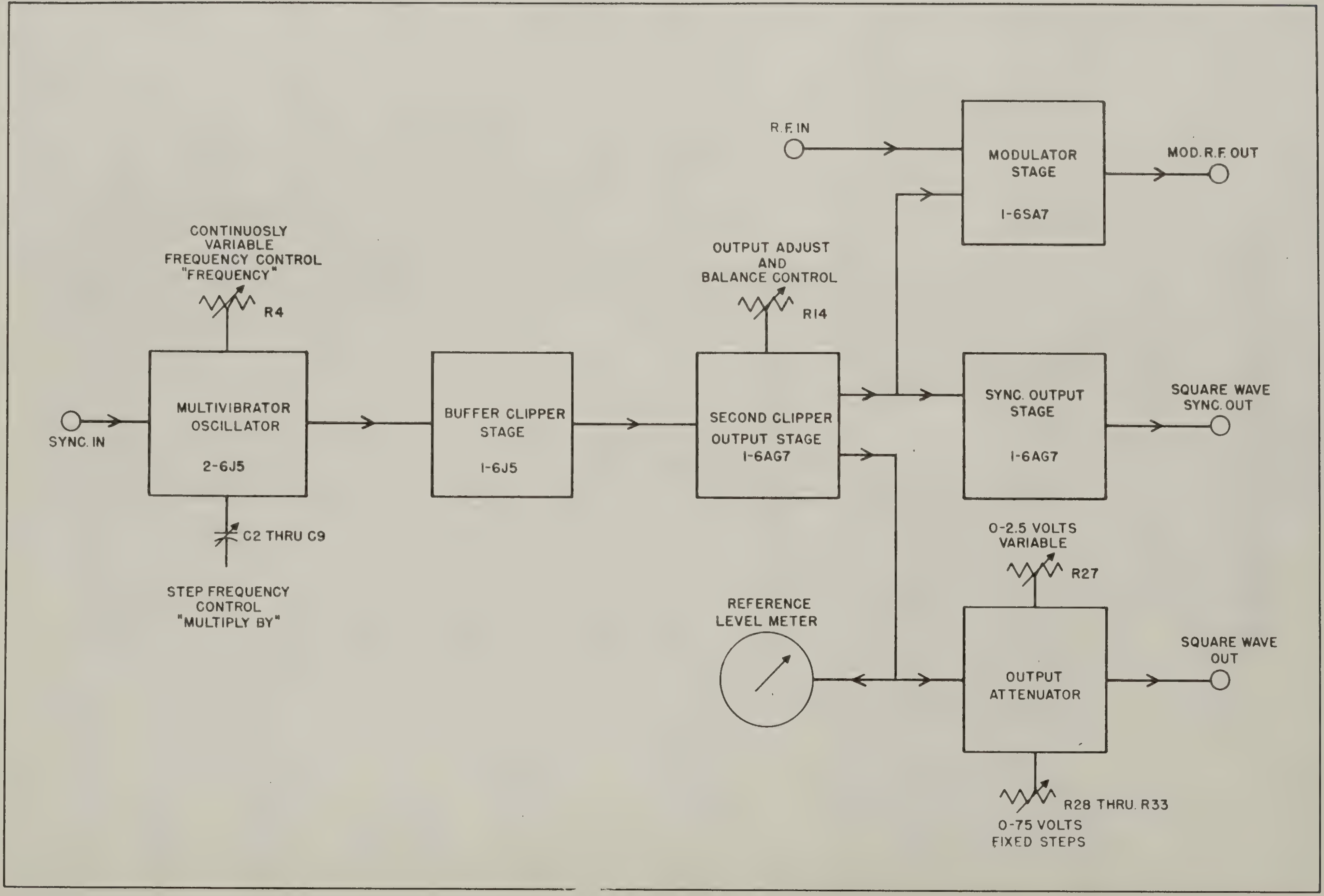


Figure 5. **Block Diagram.**

CHAPTER 4

EQUIPMENT USED IN CONJUNCTION WITH MODEL 71

Section I. ACCESSORIES

22. RECOMMENDED ACCESSORIES.

a. No special accessories are required.

(1) Short, direct connecting leads suffice for most applications.

b. It is recommended that a wide-band oscilloscope with clean transient-response characteristics be employed with the Model 71.

TABLE IV. TUBE VOLTAGE CHART.

TUBE		PLATE		SCREEN (or other grids)		CONTROL GRID		CATHODE	
No.	**Type**	**Pin**	**Volts**	**Pin**	**Volts**	**Pin**	**Volts**	**Pin**	**Volts**
VI	6J5	3	100	—	—	5	−20	8	0
V2	6J5	3	100	—	—	5	−20	8	0
V3	6J5	3	100	—	—	5	−20	8	0
V4	0D3	5	150	—	—	—	—	2	0
V5	5Y3G	4 to 6	700*	—	—	—	—	2, 8	300
V6	6AG7	8	250	6	290	4	100	5	125
V7	6AG7	8	280	6	290	4	100	5	125
V8	6SA7	3	280	8	90	5	100	6	125
				4	290				

*RMS

NOTE:

Since the power supply is operated with B+ grounded, all d-c voltages are measured to the common B— bus which is approximately 290 volts negative with respect to the chassis. EXERCISE CAUTION TO AVOID ELECTRICAL SHOCK.

D-C voltages measured with 20,000-ohms-per-volt meter.

A-C voltages measured with 1,000-ohms-per-volt meter.

Frequency set for 200 c.p.s. with FREQUENCY dial set at 20 and MULTIPLY BY dial set at X10.

OUTPUT ADJUST knob set for meter reading of 1.0.

A variation of ±20% from these values is not serious.

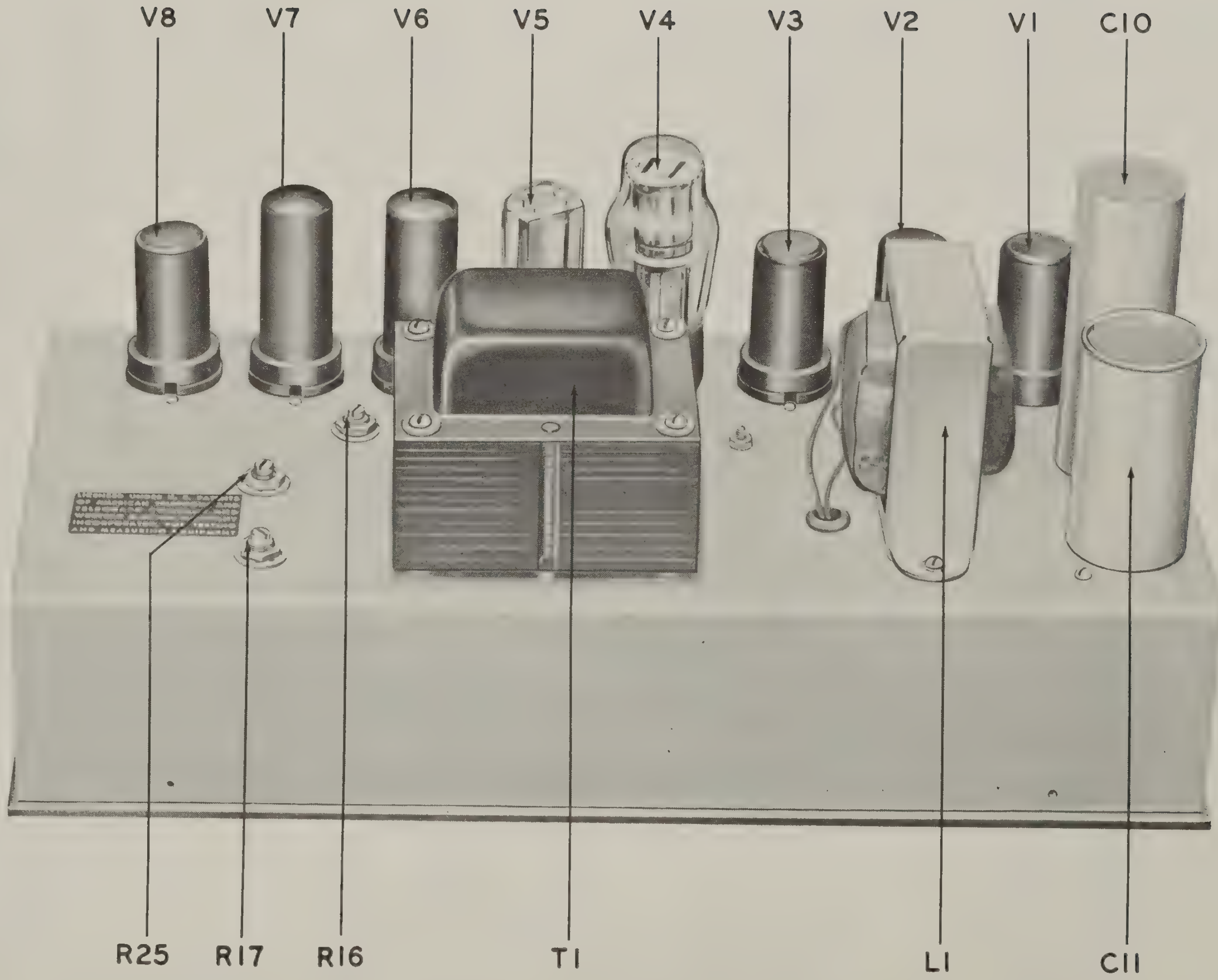


Figure 6. Rear View of Uncased Instrument.

CHAPTER 5

TECHNICAL SERVICE—MAINTENANCE INSTRUCTIONS

Section I. GENERAL

23. SCOPE.

a. The purpose of this chapter is to acquaint operating and maintenance personnel with the theory of operation of the various circuits in the Model 71 Square-Wave Generator and to describe recommended adjustment procedures.

b. Return the instrument to Measurements Corporation whenever repairs involving replacement of components is necessary.

Section II. CONDENSED THEORY OF OPERATION

24. GENERAL.

a. A block diagram of the Model 71 is shown in Figure 5.

b. The Model 71 contains a variable frequency multivibrator oscillator continuously variable from 6 to 100,000 c.p.s. followed by a buffer-clipper amplifier feeding a high-transconductance output amplifier.

c. The output amplifier is cathode coupled to a synchronizing output amplifier and to a r-f carrier modulator.

d. A regulator glow tube is employed to stabilize the plate voltage of the multivibrator and of the buffer-clipper amplifier.

25. MULTIVIBRATOR OSCILLATOR.

a. The basic square-wave signal is generated by a symmetrical multivibrator oscillator comprising the two 6J5 tubes V1 and V2 and associated resistors and capacitors.

b. The frequency of the multivibrator is controlled in decade steps of 1, 10, 100 and 1000 by means of the switch S2 which switches the capacitors C2 through C9. Continuous variation is obtained by varying the dual resistor R4.

c. The multivibrator frequency may be stabilized by injecting a synchronizing signal into the grid circuit of V1 through the resistor R1 and capacitor C1.

26. POWER SUPPLY.

a. In order to permit direct coupling between all stages, and at the same time to keep the output d-c voltage to a safe value, the B+ terminal of the power supply is grounded and all tube cathodes are operated at high negative potential with respect to ground. The tube cathodes are held at ground potential for a-c signals by the electrolytic capacitors C10.

b. The voltage-regulator tube, V4, is used to stabilize the plate voltage of V1, V2 and V3 at 150 volts.

27. BUFFER-CLIPPER STAGE.

a. The signal at the grid of V2 has a short rise time, or "flop-over" period, but sloping top and bottom. This signal is directly coupled to the grid of the buffer-clipper amplifier, V3. Since V3 is driven from cut-off to grid saturation, the signal at the output of V3 is a clean negative-going square wave of approximately 60 volts peak-to-peak amplitude.

28. SQUARE-WAVE OUTPUT STAGE.

a. A high-transconductance 6AG7 tube, V6, is used to clip the signal from V3 and to provide a low-impedance output.

b. The plate load resistance of V6, which is approximately 1500 ohms, consists of the potentiometer R27 in series with the group of resistors R28 through R33. This group of resistors, nominally selected for a tolerance of ±5%, in conjunction with S3, comprise an attenuator which provides output square-wave voltages of 0, variable 0-2.5, 5, 10, 15, 25, 50 and 75 negative peak-to-peak volts.

c. The one-milliampere meter, M1, and 56,000-ohm resistor R26, act as a d-c voltmeter which responds to the average value of the negative-going square-wave developed across the group of attenuator resistors connected in series. At the 1.0 division on the meter, the current is ⅔ of a milliampere, corresponding to an average voltage indication of 37.5 volts or 75 volts negative square-wave peak. The resistor, R25, accessible as a screw-driver adjustment behind the panel, permits the adjustment of the plate load resistance of V6 in order to produce the proper reference value of square-wave voltage.

d. The variable resistor, R14, in the cathode circuit of V6, V7 and V8 is a front panel control which permits adjustment of M1 to its reference value 1.0. Resistor R14 also acts as a balance control for the modulator, V8.

29. SYNC OUTPUT STAGE.

a. The 6AG7 tube, V7, cathode coupled to V6, provides a negative-going square-wave output of approximately 25 volts peak for synchronizing purposes.

30. MODULATOR STAGE.

a. The 6SA7 tube, V8, is a modulator arranged so that r-f carrier, or other, signals may be modulated with a square wave. The square-wave modulating signal is injected in the cathode circuit of V8. Since there is a component of this square wave in the plate circuit of V8, R21 is connected in series with R27 across which a square-wave component of opposite phase is generated. By proper adjustment of the panel balance control, R14, these signals may be made to cancel as described in paragraph 20.

Section III. TROUBLE LOCATION

31. LOCALIZING THE TROUBLE.

a. Trouble may be quickly localized by making the preliminary operational checks described in Paragraph 17 and by reference to the Trouble-Shooting Chart, Table III.

b. A chart showing normal tube voltages is given in Table IV.

c. To remove the case of the Model 71, unscrew the two screws located at the top and the two screws located at the bottom front edges of the case. Place the instrument, face down, on a soft cloth to prevent scratching. The unit may then be lifted directly from its case.

Section IV. PRE-ADJUSTMENT PROCEDURE

32. TEST EQUIPMENT REQUIRED.

a. The following equipment should be available for adjustment purposes:

Audio Oscillator with at least 2% frequency accuracy.
Cathode-ray Oscilloscope, wide-band type with response extending up to 3 to 10 megacycles.
Multi-meter with D-C sensitivity of 20,000 ohms per volt and A-C sensitivity of 1,000 ohms per volt.
Line Voltage Regulating Transformer of at least 100 watts capacity.

Section V. ADJUSTMENT PROCEDURES

33. GENERAL.

CAUTION

Do NOT attempt to adjust any control before reading the following instructions.

a. The Model 71 should be plugged into the voltage regulator and allowed to warm up for at least one-half hour.

34. OUTPUT VARIATION.

a. Turn the Output calibration knob located below the meter clockwise to the full On position. Rotate the frequency dial, I2, and the frequency multiplier switch, I4, and observe the minimum peak volt reading of the meter for any point on the calibrated range. This should be more than 1.00.

b. Turn the Output calibration knob clockwise to the minimum position. Repeat the procedure in "*a*" and observe the maximum reading on the peak voltmeter. This reading should be less than 1.00.

c. If the square-wave output of the Model 71 meets the Asymmetry Check outlined in Paragraph 35 below, the output peak amplitude of the square wave may be adjusted to fall within the above tolerance by varying the resistor R25.

35. ASYMMETRY CHECK.

a. Set the Model 71 MULTIPLY BY dial on the X10 scale and the ATTENUATOR for 50 volts output. Connect the square-wave output directly to the vertical plates of the cathode-ray oscilloscope (CRO). Set the sweep of the CRO to exactly twice the Model 71 frequency, and do not employ any sync. When the sweep frequency is exactly twice the square-wave frequency, a small break will be observed in one line of the pattern, and a small overlap in the other. Change the square-wave frequency slowly until the break closes and the point of the two waves are the same. This is the frequency setting for a symmetrical wave.

b. Set the output meter to 1.00 and change the frequency of the Model 71, covering all of the calibrated frequency ranges, and observe the maximum and minimum swings of the output meter, M1. The meter reading should fall within ±15% of the 1.00 reading; that is, a minimum reading of 0.85 volts and a maximum reading of 1.15 volts. Since the meter responds to the average value of the negative-going square wave, these readings are a relative measure of the "on" and "off" periods, or the symmetry of the square wave. Lack of symmetry may be corrected by proper selection of tubes V1, V2, V3, V6 or V7, and/or by adjustment of resistor R17.

36. FREQUENCY CALIBRATION CHECK.

a. Connect the output of the Model 71 to the vertical amplifier of the cathode-ray oscilloscope. Connect the output of the audio-frequency oscillator to the horizontal amplifier in order to obtain Lissajou patterns. Set the MULTIPLY BY dial of the Model 71 to X100 and measure the square-wave frequency by rotating the audio-oscillator frequency dial for a single loop stationary pattern. Check all of the *numbered* frequency divisions on FREQUENCY dial I2. These divisions should check to a tolerance of ±5%.

37. FREQUENCY DECADE CHECK.

a. Use the technique outlined in Paragraph 34. Set the audio oscillator to 10 Kc., and adjust the Model 71 for a single-loop stationary pattern using the MULTIPLY BY setting of X100. Leave the FREQUENCY dial, I2, of the Model 71 at this setting, and switch the MULTIPLY BY dial, I4, to X1, X10 and X1K positions. In each case, measure and record the frequency with the audio oscillator. The frequencies recorded should fall within the decade frequency tolerance of ±10%.

38. OUTPUT VOLTAGE CHECK.

a. Set the multi-meter on its 50-volt D-C range, and connect it to the output terminals of the Model 71. Set the meter of the Model 71 for a reading of 1.00. The output should be within ±20% at any frequency. The D-C voltmeter should indicate half the voltage indicated on the calibrated positions of the attenuator dials I3 and I5.

b. The square-wave SYNC output voltage measured with the D-C multi-meter should fall between 15 and 55 volts.

APPENDIX I
STORAGE AND SHIPMENT

1. STORAGE.

a. Remove dust from controls and outer surface of instrument with a clean rag.

b. Wrap instrument in heavy wrapping paper and seal seams with gummed tape or similar adhesive.

c. Store in a dry place. If excessive humidity is unavoidable the wrapped instrument should be placed in a moisture-proof bag with a sufficient quantity of drying agent, such as silica gel, to insure a dry atmosphere.

(1) When the use of bag and dessicant is necessary, the instrument should be checked at 6-month intervals to determine the effectiveness of the seal.

2. SHIPMENT.

a. Wrap the instrument with heavy wrapping paper and seal seams with gummed tape or similar adhesive.

b. Place in fibre-board carton or wooden box large enough to permit at least 3 inches of excelsior or similar packing material between the instrument and sides of the box.

(1) For export packing the instrument must be wrapped in waterproof paper and the seams sealed with glue or similar sealing compound before being placed in a wooden box.

APPENDIX II
TABLE OF REPLACEABLE PARTS

MODEL 71 SQUARE WAVE GENERATOR

11/1/60

Reference Symbol	DESCRIPTION	FUNCTION
C1	CAPACITOR, fixed: mica; 3,000 mmf. ±10%; 500 vdcw; 13/16" lg x 13/16" w. x 9/32" thick; two axial wire leads; Measurements Corp; Part H-5237.	Sync. input capacitor.
C2	CAPACITOR, fixed: silver mica; 85 mmf. ±2%; 500 vdcw; 23/32" lg x 15/32" w. x 13/64" thick; two axial wire leads; Measurements Corp. Part H-5170. (Must match C9 within 1%).	Multivibrator tuning, range 6000-100,000 cps.
C3	CAPACITOR, fixed: silver mica; 1,000 mmf. ±2%; 500 vdcw; 13/16" lg. x 13/16" w. x 9/32" thick; two axial wire leads; Measurements Corp. Part H-5169. (Must match C8 within 1%).	Multivibrator tuning, range 600-10,000 cps.
C4	CAPACITOR, fixed: mica; 10,000 mmf. ±5%; 300 vdcw; 13/16" lg x 13/32" w. x 11/32" thick; two axial wire leads; Measurements Corp. Part H-5104. (Must match C7 within 2%).	Multivibrator tuning, range 60-1000 cps.
C5	CAPACITOR, fixed: paper; 100,000 mmf. ±5%, 400 vdcw; 1-13/16"(max) lg. x 13/16"(max) dia; two axial wire leads; Measurements Corp. Part H-3756. (Must match C6 within 2%).	Multivibrator tuning, range 6-100 cps.
C6	CAPACITOR: Same as C5.	Same as C5.
C7	CAPACITOR: Same as C4.	Same as C4.
C8	CAPACITOR: Same as C3.	Same as C3.
C9	CAPACITOR: Same as C2.	Same as C2.
C10	CAPACITOR; fixed: electrolytic; 3 sections; 10mf. per section; 450 vdcw Measurements Part H-5061.	Rectifier filter.
C11	CAPACITOR, fixed: paper; 2 mf. ±20%; 600 vdcw; metal case, 2-7/8" lg. x 1-1/2" dia; two solder lug terminals; mounts by 3/4"-16 x 7/16" threaded neck; Measurements Corp. Part H-5239.	Rectifier filter.
C12	CAPACITOR: Same as C1.	RF input capacitor.
C13	CAPACITOR: Same as C1.	RF output capacitor.
E1	LAMP, incandescent: 6-8V, 0.25 amp; bulb T-3-1/4 clear; 1-1/8" lg. o/a; miniature bayonet base; burn any position. Measurements Corp. Part H-5016.	Pilot lamp.

TABLE OF REPLACEABLE PARTS

MODEL 71 SQUARE WAVE GENERATOR

Reference Symbol	DESCRIPTION	FUNCTION
F1	FUSE, cartridge: 1-1/4 amp. Measurements H-5018-10.	Power line fuse.
I1	LIGHT, indicator: with smooth frosted back red lens; for miniature bayonet base lamp with T-3-1/4 bulb; mounts in single 11/16" dia. hole; horizontally mounted; lamp replaceable from front; two insulated solder lug terminals. Measurements Corp. Part H-5019.	Pilot light.
I2	DIAL, control: moveable scale type; CYCLES; 5 to 100; counterclockwise; 21 divisions marked 6 10, 20, 30, 50, 100; individually calibrated; flat metal disk with skirted knob; for 1/4" dia. shaft; 2-3/4" dia. x 1" high o/a; two #10-32 setscrews. Measurements Corp. Part H-5240.	Frequency control.
I3	DIAL, control: moveable scale type; for variable output attenuator; 0 to 2.5; counterclockwise; 25 divisions marked 0, .5, 1, 1.5, 2.5; individually calibrated; flat metal disk with skirted knob; for 1/4" dia shaft; 2-3/4" dia. x 1" high o/a; two #10-32 setscrews. Measurements Corp. Part H-5241.	Variable output attenuator control.
I4	DIAL, control: moveable scale type; MULTIPLY BY; counterclockwise; four indications, marked 1, 10, 100, 1K; flat metal disk with fluted knob; for 1/4" dia. shaft; 2" dia. x 3/4" high o/a; two #8-32 setscrews. Measurements Corp. Part H-5242.	Frequency range control.
I5	DIAL, control: moveable scale type; for stepped output; counterclockwise; 8 indications marked 0, VAR, 5, 10, 15, 25, 50, 75; flat metal disk with fluted knob; for 1/4" dia. shaft; 2" dia. x 3/4" high o/a; two #8-32 setscrews. Measurements Corp. Part H-5243.	Fixed step output control.
L1	REACTOR: filter choke; one section; 15 henries @ 0.120 amp. DC; 300-375 ohms DC resistance; 1500V; rms insulation; open frame; 2-1/2" lg. x 1-1/2" w. x 3-1/8" high; two integral mtg. flanges; two mtg. holes 0.161" dia. spaced at 3-1/8" c to c; two wire leads at one side. Measurements Corp. Part H-2152.	Filter for high voltage rectifier.

TABLE OF REPLACEABLE PARTS

MODEL 71 SQUARE WAVE GENERATOR

Reference Symbol	DESCRIPTION	FUNCTION
M1	METER: ammeter; DC type; 1 milliampere full scale; square bakelite case; panel mtg. type; barrel 2-3/4" dia. x 1-3/8" deep behind panel face; square flange 3" w. x 3" h; accuracy ±2.0% at point 1 (.66 ma) on scale; D'Arsonval movement; 50 to 500 ohms across terminals; calibrated for non-magnetic panel; scale "PEAK VOLTS", 30 divisions marked at 0, .5, 1, 1.5; black numerals; white background; black pointer; 4 mtg. studs #4-36 x 3/8" lg. at 2-1/4" horiz. and 2-1/4" vert. centers; two stud terminals at back. Measurements Corp. Part H-736.	Output indicator.
P1	CONNECTOR, plug: two flat, male, parallel contacts; straight type; part of W1.	Power line connector.
R1	RESISTOR, fixed: composition; 100,000 ohms +10%; 1/2 watt; 3/8" lg. x 9/64" dia; two axial wire leads. Measurements Corp. Part H-3728-104.	Sync. input resistor.
R2	RESISTOR, fixed: composition; 20,000 ohms ±5%; 1/2 watt; 3/8" lg. x 9/64" dia; two axial wire leads. Measurements Corp. Part H-3727-203.	V1 grid resistor.
R3	RESISTOR; Same as R2.	V2 grid resistor.
R4	RESISTOR, variable: composition; two sections. matched; each section 550,000 ohms ±10%; 1 watt nominal power rating each section; reverse audio taper; 3 solder lug terminals each section; body dim. 1-3/8" dia. x 1-1/6" deep; flatted metal shaft, 1/4" dia. x 1" lg. from mtg. surface; normal torque; contact arm insulated; no "off" position; mounts by 3/8"-32 x 3/8" lg. bushing. Measurements Corp. Part H-2752.	Frequency tuning control.
R5	RESISTOR, fixed: composition; 20,000 ohms ±5%; 2 watts; 11/16" lg. x 5/16" dia; two axial wire leads. Measurements Corp. Part H-3733-203.	V1 plate resistor.
R6	RESISTOR: Same as R5.	V2 plate resistor.
R7	RESISTOR, fixed: composition; 22,000 ohms ±10%; 2 watts; 11/16" lg. x 5/16" dia; two axial wire leads. Measurements Corp. Part H-3734-223.	V3 plate resistor.
R8	RESISTOR, fixed: wire wound; 2500 ohms ±10%; 20 watts; 2-1/8" lg. x 5/8" dia; ceramic tube, vitreous enamel coated; two solder lug terminals; mounts with #6-32 screw through center. Measurements Corp. Part H-5244.	Current limiting resistor, tube V4.
R9	RESISTOR, fixed: composition; 4700 ohms ±10%; 2 watts; 11/16" lg. x 5/16" dia; two axial wire leads. Measurements Corp. Part H-3734-472.	Cathode resistor, tubes V6, V7.

TABLE OF REPLACEABLE PARTS

MODEL 71 SQUARE WAVE GENERATOR

Reference Symbol	DESCRIPTION	FUNCTION
R10	RESISTOR: Same as R9.	Same as R9.
R11	RESISTOR: Same as R9.	Same as R9.
R12	RESISTOR: Same as R9.	Same as R9.
R13	RESISTOR: Same as R9.	Same as R9.
R14	RESISTOR, variable: wire wound; one section; 1000 ohms + %; 25 watts rating; linear taper; three solder lug terminals; round metal shaft 1/4" dia. x 7/8" lg. from mtg. surface; contact arm insulated; mounts by 3/8"-32 x 3/8" lg. bushing. Measurements Corp. Part H-5245.	Output adjustment.
R15	RESISTOR, fixed: composition; 10,000 ohms ±5%; 2 watts; 11/16" lg. x 5/16" dia; two axial wire leads. Measurements Corp. Part H-3733-103.	Voltage divider.
R16	RESISTOR, variable: wire wound; one section; 1000 ohms ±10%; 3 watts rating; linear taper; three solder lug terminals; round metal shaft, screwdriver slotted, 1/4" dia. x 1/2" lg. from mtg. surface; contact arm insulated; mounts by 3/8"-32 x 3/8" lg. bushing. Measurements Corp. Part H-5544.	Bias adjustment V-8.
R17	RESISTOR: Same as R16.	Bias adjustment V-7.
R18	RESISTOR, fixed: composition; 4700 ohms ±10%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-3728-472.	Grid resistor V-8.
R19	RESISTOR, fixed: composition; 33 ohms ±10%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-3728-330.	Parasitic suppressor V-8.
R20	RESISTOR: Same as R7.	Voltage divider.
R21	RESISTOR, fixed: composition; 560 ohms ±10%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-3728-561.	V8 plate resistor.
R22	RESISTOR: Same as R9.	V7 plate resistor.
R23	RESISTOR: Same as R9.	V7 plate resistor.
R24	RESISTOR: Same as R9.	V7 plate resistor.

TABLE OF REPLACEABLE PARTS

MODEL 71 SQUARE WAVE GENERATOR

Reference Symbol	DESCRIPTION	FUNCTION
R25	RESISTOR, variable: composition; one section; 50,000 ohms ±20%; 2 watts nominal power rating; clockwise log taper; 3 solder lug terminals; body dim. 1-1/16" dia. x 9/16" deep; screwdriver slotted metal shaft; 1/4" dia. x 5/8" lg. from mtg. surface; normal torque; no "off" position; mounts by 3/8"-32 x 1/2" lg. bushing. Measurements Corp. Part H-5246.	Output meter adjustment.
R26	RESISTOR, fixed: deposited film; 56K ohms ±2%; 1 watt; 3/8" dia. x 1" lg; ceramic tube; moisture-proofed; two radial wire leads. Measurements Corp. Part H-3745-17.	V6 plate resistor.
R27	RESISTOR, variable: composition; one section; 50 ohms ±10%; 3 watts nominal rating; clockwise linear taper; three solder lug terminals; body dim. 1-5/8" dia. x 13/16" deep; round metal shaft 1/4" dia. x 1" lg. from mtg. surface; normal torque; no "off" position; mounts by 3/8"-32 x 3/8" lg. bushing. Measurements Corp. Part H-333.	Variable output control.
R28	RESISTOR, fixed: composition; 47 ohms ±5%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-3727-470.	p/o output attenuator.
R29	RESISTOR, fixed: composition; 100 ohms ±5%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-3727-101.	Same as R28.
R30	RESISTOR: Same as R29.	Same as R28.
R31	RESISTOR, fixed: composition; 200 ohms ±5%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-3727-201.	Same as R28.
R32	RESISTOR, fixed: composition; 500 ohms ±5%; comprises a matched pair, each 1000 ohms ±10%; 1/2 watt; 3/8" lg. x 9/64" dia; two radial wire leads. Measurements Corp. Part H-5247.	Same as R28.
R33	RESISTOR: Same as R32.	Same as R28.
S1	SWITCH, toggle: SPST; molded phenolic body; 1-1/4" lg. x 11/16" w. x 11/16" deep; 1/2" lg. ball tipped handle; locking action; back connected, two solder lug terminals; single hole mtg; bushing 15/32"-32 x 3/8" lg. Measurements Corp. Part H-383-1.	Power supply.
S2	SWITCH, rotary: 2 pole, 4 position; brass silver plated contacts; phenolic wafers; 2-1/8" w. x 2-3/8" h. x 1" lg. from mtg. surface; non-shorting type contacts; locking action; solder lug terminals; single hole mtg; bushing 3/8"-32 x 3/8" lg; flatted metal shaft 1/4" dia. x 7/8" lg. from mtg. surface. Measurements Corp. Part H-2160.	Frequency range selector.

TABLE OF REPLACEABLE PARTS

MODEL 71 SQUARE WAVE GENERATOR

Reference Symbol	DESCRIPTION	FUNCTION
S3	SWITCH, rotary: 1 pole, 8 position; brass silver plated contacts; phenolic wafer; 2-1/8" w. x 2-3/8" h. x 1" lg. from mtg. surface; non-shorting type contacts; locking action; solder lug terminals; single hole mtg; bushing 3/8"-32 x 3/8" lg; flatted metal shaft 1/4" dia. x 7/8" lg. from mtg. surface. Measurements Corp. Part H-2159.	Output attenuator selector.
T1	TRANSFORMER: power, plate and filament type; input 117V, 50-60 cycle; single phase; three output windings; Sec. #1, 350-0-350 volts at 120 ma; Sec. #2, 5 volts at 2 amp; Sec. #3, 6.3 volts at 4.7 amp; shell type metal case 3-1/8" w. x 3-3/4" d. x 3" h; four mtg. screws spaced 3-1/8" x 2-1/2" c to c. Measurements Corp. Part H-5060.	Power transformer.
V1	TUBE, electron: triode; RTMA #6J5.	p/o multivibrator.
V2	TUBE, electron: Same as V1.	p/o multivibrator.
V3	TUBE, electron: Same as V1.	Buffer-clipper.
V4	TUBE, electron: diode; RTMA #0D3/VR-150.	Voltage regulator.
V5	TUBE, electron: duodiode; RTMA #5Y3GT	Rectifier.
V6	TUBE, electron: pentode; RTMA #6AG7.	Output ampl.
V7	TUBE, electron: Same as V6.	Output ampl.
V8	TUBE, electron: heptode; RTMA #6SA7.	RF modulator.
W1	CABLE, power, electrical: two copper conductors, #18 AWG; 6 ft. lg.; one end terminated in plug (P1), other end unterminated. Measurements Corporation part H- 704	Power line connection.
XV1	SOCKET, electron tube: octal; eight spring brass cadmium plated contacts; round plastic body 1-3/16" dia. x 1/2" h. excluding terminals; one piece saddle mtg; two mtg. holes 9/64" dia. on 1-1/2" centers. Measurements Corp. Part H-5056.	Holds V1.
XV2-XV8 incl.	SOCKET: Each same as XV1.	Hold V2 - V8 incl.
XF1	FUSEHOLDER; panel type; for one cartridge type fuse; black bakelite; 15 amp.; 250 V.; 11/16" dia. x 2-1/2" by O.A.; 1/2" threaded body; for panel hole mtg; 2 solder lug terminals; bayonet type knob; includes washer and nut. Measurements Corp. Dwg. H-5017.	Mounting for line fuse, F1

APPENDIX III

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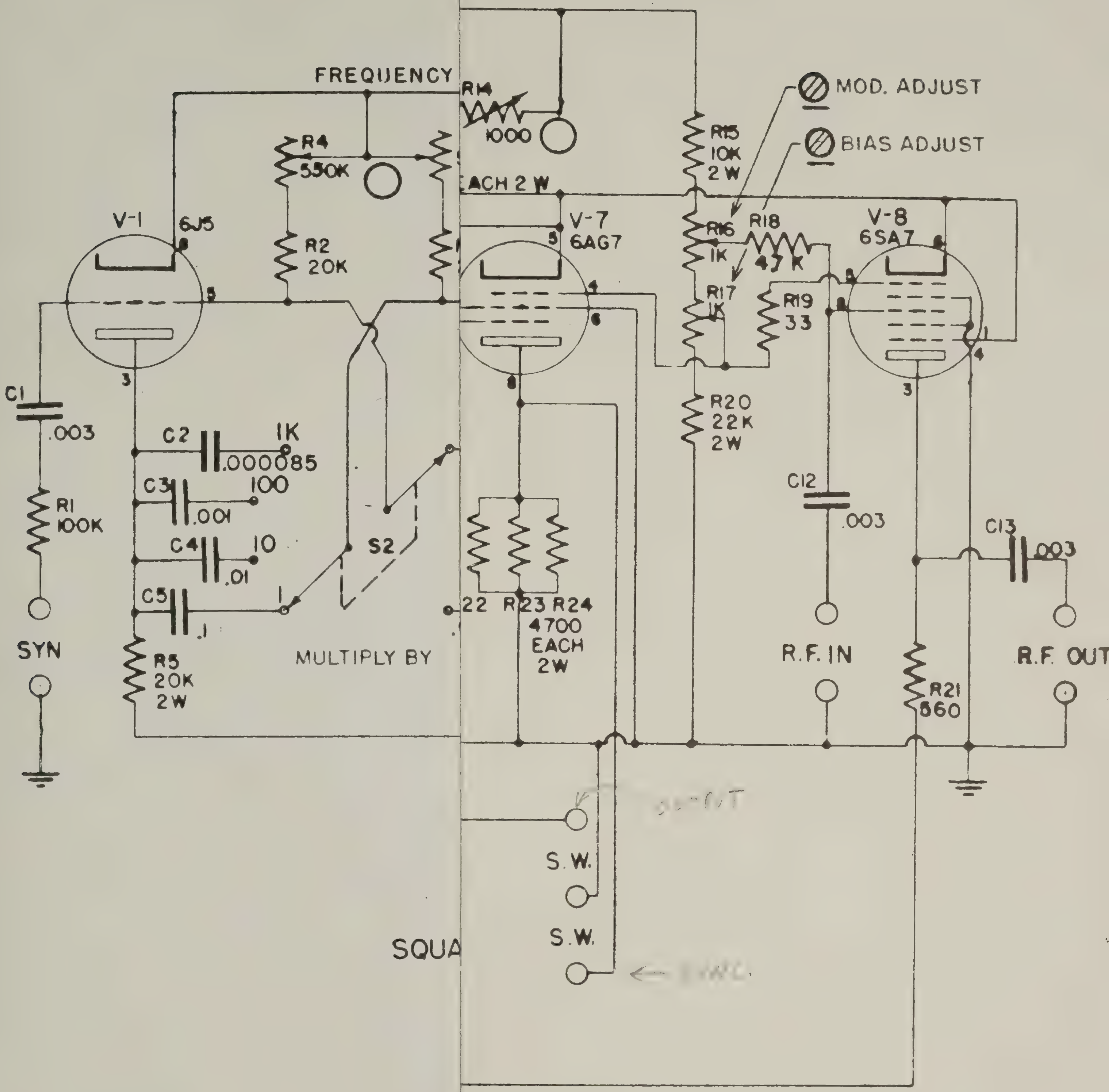
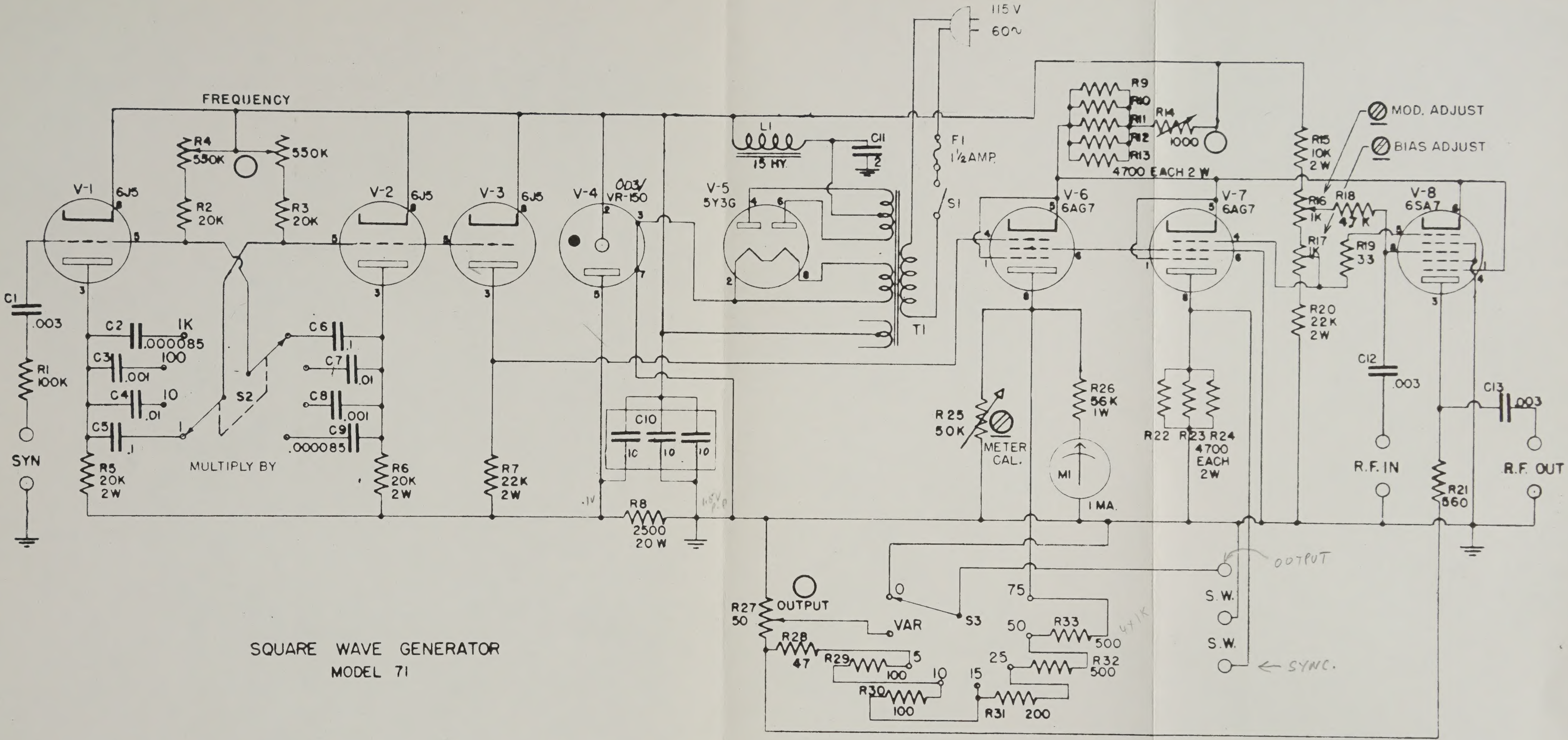

FREQUENCY
R14
1000
R4
550K
EACH 2 W
R2
20K
V-1
6J5
V-7
6AG7
V-8
6SA7
R15
10K
2 W
MOD. ADJUST
BIAS ADJUST
R16
1K
R17
1K
R18
47 K
R19
33
R20
22K
2W
C1
.003
C2
.000085
1K
C3
.001
100
C4
.01
10
C5
.1
1
S2
R1
100K
SYN
R5
20K
2W
MULTIPLY BY
22
R23
R24
4700
EACH
2W
C12
.003
C13
.003
R.F. IN
R.F. OUT
R21
560
S.W.
S.W.
SQUA

B-2161-S



SQUARE WAVE GENERATOR
MODEL 71

UNLESS OTHERWISE NOTED:
ALL CAPACITANCES IN MICRO-FARADS.
ALL RESISTANCES IN OHMS.
ALL FIXED RESISTORS ½ WATT.
○ FRONT PANEL CONTROL.
⊘ SCREW DRIVER ADJUSTMENT BEHIND PANEL.

B-2161-S

MEASUREMENTS

BOX 180, BOONTON
NEW JERSEY